THE DOCTORAL SCHOOL OF IPPT PAN

COURSE OFFERED IN THE DOCTORAL SCHOOL OF IPPT PAN

Name of the course	Polish	**Podstawy matematyki w naukach inżynieryjnych - I**				
	English	**Basic Mathematics in Engineering Science - I**				
Type of the course	**Basic course**					
Course coordinator	**Wasyl Kowalczuk, PhD, D.Sc.**		Course teachers	**Wasyl Kowalczuk, PhD, D.Sc. Barbara Gołubowska, PhD**		
Implementing unit	**ZTOCiN**	Scientific discipline / disciplines	**Mechanical engineering**			
Level of education	**Doctoral studies**	Semester	**Winter**			
Language of the course	**English**					
Type of assessment	**Examination**	Number of hours in a semester	**60**	ECTS credits	**4**	

Type of classes		Lecture	Auditory classes	Project classes	Laboratory	Seminar
Number of hours	in a week	**2**	**2**	**0**	**0**	**0**
	in a semester	**30**	**30**	**0**	**0**	**0**

1. Prerequisites

The basic knowledge of mathematics obtained during the university or technical studies is demanded, with the special stress laid on the ability to think logically and rigorously.

2. Course objectives

The aim of this course is to recollect and, if necessary, supplement the basic knowledge of mathematics, which the PhD students have received during their university or technical studies, with the special stress laid on the practical applications of presented mathematical concepts and methods in the field of engineering science.

3. Course content (separate for each type of classes)

Lecture

Main topics:

1. Elements of mathematical logic, propositional and predicate calculus, set theory and algebra of sets, relations and their properties, Kuratowski-Zorn lemma and Well-ordering (Zermelo's) theorem, Zermelo-Fraenkel axiomatization (ZF) of set theory with axiom of choice (AC), continuum hypothesis (CH) and generalized continuum hypothesis (GCH), cardinality and Cantor's theorem.
2. Fuzzy logic as a form of many-valued logic, fuzzy set theory, fuzzy relations and triangular (S and T) norms, superposition of two fuzzy relations and a fuzzy set with a fuzzy relation, fuzzy implication, linguistic variable, fuzzy numbers and directed fuzzy numbers, fuzzy controllers, architecture of Fuzzy Inference Systems (FIS), methods of defuzzification, Mamdani- and Takagi-Sugeno-type fuzzy controllers, Adaptive Neural/Network-based Fuzzy Inference System (ANFIS).
3. Elements of probability theory, probability space and Kolmogorov axioms of probability, conditional probability, law of total probability, epistemological interpretation of Bayes' theorem, prior and posterior probabilities, usage in medicine (rare diseases), Monty Hall problem, weak and strong laws of large numbers, discrete and continuous random variables, cumulative distribution function (CDF), probability density function (PDF), expected mean value and higher raw and central moments (variance, skewness, kurtosis, etc.), partial moments, quantiles, discrete (Bernoulli, binomial, Poisson) and continuous (uniform, exponential, normal, Pareto) probability distributions,

Pareto principle, Lorentz curve, Gini coefficient, Markov's and Chebyshev's inequalities, Lindeberg-Levy central limit theorem, chi-squared and Student's t-distributions.
Laboratory
- does not apply

4. Learning outcomes			
Number of the learning outcome	Learning outcomes description	Reference to the learning outcomes according to the 8th level of PRK	Learning outcomes verification methods*
Knowledge			
1	The graduate acquires basic knowledge of mathematics in the field of mathematical logic, fuzzy logic, and probability theory.	P8S_WG	examination
2	The graduate knows how to apply the acquired knowledge to solution of practical problems, especially in the field of engineering science.	P8S_WK	assessment of activity during auditory classes
Skills			
1	The graduate is able to solve practical problems in the field of mathematical logic, fuzzy logic, and probability theory.	P8S_UW	assessment of activity during auditory classes and examination
2	The graduate is able to apply the acquired knowledge directly to the field of his/her scientific research as well as disseminate the obtained results to the scientific community.	P8S_UW	assessment of activity during auditory classes
Communication			
1	The graduate is able to initiate a debate and participate in scientific discourse, as well as to provide appropriate arguments in scientific discussions and public debates on various topics.	P8S_UK	assessment of activity during auditory classes
Social competences			
1	The graduate is ready to think and act in a creative and entrepreneurial way.	P8S_KO	assessment of activity during auditory classes
2	The graduate is ready to critically evaluate the achievements of the represented scientific discipline, including his or her own contribution to the development of this discipline.	P8S_KK	assessment of activity during auditory classes

*Allowed learning outcomes verification methods: exam; oral exam; written test; oral test; project evaluation; report evaluation; presentation evaluation; active participation during classes; homework; tests

5. Assessment criteria
Assessment of activity during auditory classes, result of final examination.

6. Literature
Primary references: [1] H. B. Enderton, A mathematical introduction to logic, Academic Press, 2000. [2] W. Feller, An introduction to probability theory and its applications, Vol. 1, Wiley, 1968, Vol.2, Wiley, 1971. Secondary references: [1] W. Pedrycz, Fuzzy control and fuzzy systems, Research Studies Press Ltd., 1993. [2] K. M. Passino, S. Yurkovich, Fuzzy Control, Addison Wesley Longman, Menlo Park, CA, 1998.

7. PhD student's workload necessary to achieve the learning outcomes**		
No.	Description	Number of hours
1	Hours of scheduled instruction given by the lecturer in the classroom	**60**
2	Hours of consultations with the lecturer, exams, tests, etc.	**15**
3	Amount of time devoted to the preparation for classes, preparation of presentations, reports, projects, homework	**30**
4	Amount of time devoted to the preparation for exams, test, assessments	**15**
	Total number of hours	**120**
	ECTS credits	**4**

** 1 ECTS = 25–30 hours of the PhD students work (2 ECTS ≈ 60 hours; 4 ECTS ≈ 110 hours, etc.)